soap bubbles or between plates of glass when pressed together and in films of oil on water. The diffraction rings seen about a bright light when viewed through a dusty atmosphere, or through a very narrow slit are also cases of optical interference.

In general we may say that when a wave of light has just arrived at any surface every atom of that surface is at that moment just beginning its minute vibration that produces in the human eye the effect called light. Each of these atoms not only oscillates to and fro, but also sets in motion the atom next in front of it, with, however, an appreciable lag in time. From each atom there proceeds a series of oscillations such that all atoms at the same distance from the initial one just begin to move at the same moment. The distance between two atoms that are in the same phase of motion is the length of a wave of light. The atoms that are just beginning to move in the same direction at the same moment make up a wave front. The vibrations proceeding from the atoms in a wave front often interfere with each other. Two beams of light inclined at a small angle to each other may produce brightness in some portions of the region where they interfere with each other and darkness in another portion, so that the whole space may be filled with alternating bright and dark regions. If the beams are stationary, then, these bright and dark patches will also be so, but if the beams are moving or flickering the dark patches will have corresponding motions. Analogous quiet patches are observed when waves of water or of sound interfere with each other.

If we look through a very perfect telescope at a bright star we shall see the flickering movements peculiar to the beams of light passing through the earth's atmosphere. If we pull the eye piece of the telescope forward, so as to convert the sharp image of the star into a large circular blurr, we shall obtain virtually a small image of the condition of affairs. If the glass is imperfect, we shall see its imperfections. If the air, either of the atmosphere beyond the glass or within the tube of the telescope, has any imperfection as to homogeneity, we shall see its effect, since it will produce slightly convergent rays of light, and resulting interferences, and we shall see bright and dark spots or bright and dark bands covering the surface of the lens. As these atmospheric imperfections are usually in motion, either horizontally with the wind, or vertically, because of temperature or irregular eddies, therefore, the bands and spots will appear in motion across the lens. It would not be fair to consider this motion as an indication of the direction of the wind unless we are sure that it is caused by the wind only and is not affected by any vertical convection.

The frequency of the oscillations of the beams of light is best studied by the use of the scintillometer, which is a simple device by means of which the sharp well defined image of the star is made to move around the field of view rapidly in a circle. We at once perceive this circle broken up into parts or bright lines separated by dark spaces: if the image of the star is made to rotate rapidly enough, we may easily count the number of alternations of brightness and darkness per second, corresponding, therefore, to the number of small masses of warm and cold air that have passed across the line of sight in that time.

The character of the interference phenomena may also be studied by photographing the diffuse image of the star, as has been done by A. E. Douglass, at the Lowell Observatory, Flagstaff, Arizona, a report on which was published by him in the American Meteorological Journal, March, 1895, Vol. XI, pp. 395–413. He states that his first observation at that observatory, September 28, 1894, showed that a swift northeast and a slow north or northwest current were present. The distance between the bands as they crossed the objective he called the "breadth of the wave;" but this "wave" is simply the optical appearance on the object glass and has no known connection with the waves of the atmosphere. It is a resulting optical effect, and it would be a mistake to hastily adopt the conclusion that we are observing waves in the upper air due to the wind; we observe only the "interference bands." When the sun shines through a basin of water whose surface is in wavy motion, lines or spots of brightness and darkness are seen at the bottom of the vessel, and these do have some simple relation to the wave surfaces, but this is not the case with the interference bands observed by Mr. Douglass's method. It is possible that by long-continued study of these telescopic phenomena one may be able to deduce important information with regard to the condition of the atmosphere, and there is reason to hope that Mr. Douglass's observations at Flagstaff will be repeated in other localities. He himself has stated that his "waves" change their size in the presence of clouds and that their motions have some connection with the lower isobars. The method of determining the distance or location of the atmospheric disturbances devised by Mr. Douglass seems to us to need revision. We are simply observing one set of interference bands out of the myriads that must exist between the eye and the source of disturbance.

In an article in the Monthly Notices of the Royal Astronomical Society for November, 1902, Mr. Percival Lowell, Proprietor and Director of the late Flagstaff Observatory, announces that expeditions should be sent to various portions of the globe in order to ascertain where atmospheric conditions are most favorable for the best astronomical work. Speaking of what constitutes satisfactory or unsatisfactory vision of the celestial bodies, he says:

> Studies directed to that end have resulted in a knowledge of the conditions which constitute good or bad seeing. * * * The basis of the matter lies in the discovery that systems of waves traverse the air, several of these systems being present at once at various levels above the earth's surface. The waves composing any given system are constant in size and differ for the different currents all the way from a fraction of an inch to several feet in length. If the wave be less than the diameter of the object glass from crest to crest, the image is confused by the unequal refraction from the different phases of the wave; if the wave be longer than this, a bodily oscillation of the whole image results. The first is fatal to good definition, the second to accurate micrometric measurement.
>
> It is possible to see these waves by taking out the eyepiece and putting one's eye in the focus of the instrument when the tube is pointed at some sufficiently bright light. It is further possible to measure their effect by carefully noting the character of the spurious disk and rings made by a star and the extent of the swing of the image in the field of view. By combining the amount of confusion with the degree of bodily motion of the resulting image the definition at any time and place can be accurately and absolutely recorded.
>
> The increasing perfection of the optical image of a star testifies to the increasing lack of damaging currents with reference to the object glass used. It records all the waves below a certain wave length. Similarly the amount of bodily motion registers all those above that length. The two taken together give account of all the currents independent of the glass.—*C. A.*

METEOROLOGICAL STATIONS IN AFRICA.

We take pleasure in announcing that, in connection with the work of the Georgetown College Observatory, in charge of Rev. J. G. Hagen, S. J., an auxiliary observatory is to be established by Rev. Edmund Goetz, S. J., at Buluwayo, Rhodesia, South Africa. This new station will attend to meteorology as well as to astronomy, and will be in latitude 20.5° south, longitude 29° east. The meteorological observatory at Kimberley, in charge of J. R. Sutton, and known as the Kenilworth Observatory, is in latitude 26.5° south, and longitude 25° east. The station Zomba in British Central Africa is in latitude 15° 22′ south, and longitude 35° 18′ east, or a few degrees south of Lake Nyassa, at an altitude of 2,948 feet. These few stations are but samples of the hundreds that are now being occupied throughout those portions of Africa that are accessible to modern civilization.—*C. A.*

ANALOGOUS STORMS.

A correspondent inquires whether the cyclones that enter the United States via Arizona and New Mexico are West Indian hurricanes of low intensity, which have swung across Mexico, and whether the cyclones which come to us via British Columbia are East Indian typhoons that have crossed the North Pacific?

We believe that it is generally agreed that a West Indian cyclone is one that originated in or near, and moves through or near the West Indian region. It would be a violent extension of this definition to apply this term to storms that do not come anywhere near the West Indies; in the same way we should object to speaking of the storms that cross over British Columbia as East Indian typhoons, unless it can be shown that they really come from the East Indies. We believe there is but one case plausibly established, in which an East Indian typhoon did continue uninterruptedly to the coast of British Columbia, and also one case of a West Indian hurricane that can be traced to the coast of Norway. But these are entirely exceptional.

Cyclonic storms most frequently pursue certain routes, which are shown in Weather Bureau Bulletin A. The diagrams copied from that will be found in many text-books, but while these favored routes extend over large portions of the globe, yet no one storm continues long enough to pursue the whole route. An East Indian typhoon, or a West Indian hurricane, after moving along for a week or two dies away, and is soon replaced by a new storm, for storms may originate anywhere within these favored routes. It is not at all likely that a West Indian hurricane, originating near the coast of Africa, can have any nearer relationship than that of cousin to the storms that begin as low pressures in the Gulf of California, and advance eastward over Arizona and New Mexico. They are analogous but not identical.—*C. A.*

CORRIGENDA.

MONTHLY WEATHER REVIEW, September, 1902, page 472, Table 1, in the last three columns insert the following totals: 257.8; 322.2; 72.18, respectively.

MONTHLY WEATHER REVIEW, April, 1902, page 230, column 1, footnote (a) should read "published by the United States Congress in 1901 in the Report .... on Deep Waterways, 56th Congress, 2d Session, House Doc. No. 149."

In all previous REVIEWS, in Table 4, The Climatology of Costa Rica, in columns 2, 3, and 4, read "millimeters" for "inches." In same table for October, 1902, column 4, for "75.73 mm." read "757.30 mm."

SERIAL NUMBERS FOR WEATHER BUREAU PUBLICATIONS.

Many inquiries are received by the Weather Bureau officials as to the meaning of the serial numbers (e. g., W. B. No. 276) usually printed in the upper left-hand corner of the cover or title page of the Weather Bureau publications. In 1895 a Departmental order or circular was issued requiring that a serial number be given to every Weather Bureau publication that has a full title page or cover. By counting up previous publications it was concluded that the first publication of 1895 should be numbered 60; the publications previous to that date probably exceed this number, but that is of little consequence as they have never received whatever serial number properly belonged to them. The series includes all folio, quarto, and octavo bulletins, annual reports, and the successive numbers of the MONTHLY WEATHER REVIEW. As the numbers beginning with January, 1895, have been given to all publications of importance, except lithograph maps, those who desire to obtain a complete set of Weather Bureau publications are tempted to call for all these serial numbers; but this is unnecessary because so many of them are absorbed in the successive volumes of the MONTHLY WEATHER REVIEW, and others consist of instructions relative to instruments that can hardly be of general interest. At first the separate prints from the MONTHLY WEATHER REVIEW received a title page and serial number, but since December 21, 1898, this has not generally been done. A careful examination of the following list will show the reader whether any given serial number is likely to be of value to him, or worthy of a place on the shelves of a library. The authors of bulletins and of separate reprints from the MONTHLY WEATHER REVIEW are mentioned by name. In other publications the author's name is not so important and is omitted. The asterisk signifies that no copies remain for distribution.

60. Monthly Weather Review for January, 1895. Vol. XXIII, No. 1.

61. * Instructions to Observers and Code for Enciphering Reports at Cotton Region and Sugar and Rice Stations of the Weather Bureau.

62. Monthly Weather Review and Annual Summary for 1894. Vol. XXII, No. 13.

63. * E. B. Garriott. Studies of Weather Types and Storms. No. 1.—Types of Storms in January. Extract from Monthly Weather Review.

64. Monthly Weather Review for February, 1895. Vol. XXIII, No. 2.

65. Monthly Weather Review for March, 1895. Vol. XXIII, No. 3.

66. C. F. Marvin. Instructions for use of Maximum and Minimum Thermometers. Circular B. Revised Edition.

67. C. F. Marvin. Instructions for use of The Rain Gage. Circular C. Revised Edition.

68. Monthly Weather Review for April, 1895. Vol. XXIII, No. 4.

69. * Climate and Health. Number One.

70. Monthly Weather Review for May, 1895. Vol. XXIII, No. 5.

71. * Climate and Health. Number Two.

72. Monthly Weather Review for June, 1895. Vol. XXIII, No. 6.

73. * Climate and Health. Number Three.

74. Monthly Weather Review for July, 1895. Vol. XXIII, No. 7.

75. * Climate and Health. Number Four.

76. Monthly Weather Review for August, 1895. Vol. XXIII, No. 8.

77. Bulletin No 16. L. E. Jewell. The Determination of the Relative Quantities of Aqueous Vapor in the Atmosphere by Means of the Absorption Lines of the Spectrum.

78. * Climate and Health. Number Five.

79. Monthly Weather Review for September, 1895. Vol. XXIII, No. 9.

80. E. B. Garriott. Instructions to Wind-Signal [Storm Warning] Displaymen of the Weather Bureau.

81. O. L. Fassig. Statistics of State Weather Services. Extract from Monthly Weather Review.

82. * Climate and Health. Number Six.

83. Monthly Weather Review for October, 1895. Vol. XXIII, No. 10.

84. * Climate and Health. Vol. II, No. 1.

85. H. H. C. Dunwoody. Departures from Normal Temperatures and Rainfall, with Crop Yields in Nebraska.

86. * H. E. Williams. Injury from Frost and Methods of Protection.

87. * Display of Wind Signals on the Great Lakes.

88. * Bulletin No. 17. [Willis L. Moore.] The Work of the Weather Bureau in Connection with the Rivers of the United States.

89. * Monthly Weather Review for November, 1895. Vol. XXIII, No. 11.

90. Bulletin No. 18. [James Berry.] Report of the Fourth Annual Meeting of the American Association of State Weather Services, held at Indianapolis, Ind., October 16 and 17, 1895.

91. * Monthly Weather Review for December, 1895. Vol. XXIII, No. 12.

92. E. B. Garriott and others. Studies of Weather Types and Storms. Part II. Extract from Monthly Weather Review.

93. * Climate and Health. Vol. II, No. 2.

94. Monthly Weather Review and Annual Summary for 1895. Vol. XXIII, No. 13.

95. Monthly Weather Review for January, 1896. Vol. XXIV, No. 1.

96. * Climate and Health. Vol. II, No. 3.

97. * Bulletin No. 19. A. J. Henry. Report on the Relative Humidity of Southern New England and other localities.

98. Monthly Weather Review for February, 1896. Vol. XXIV, No. 2.

99. Monthly Weather Review for March, 1896. Vol. XXIV, No. 3.

100. Bulletin No. 13. H. E. Williams. Temperatures Injurious to Food Products in Storage and During Transportation, and Methods of Protection from the same. Reprinted as Farmers' Bulletin No. 125.

101. Monthly Weather Review for April, 1896. Vol. XXIV, No. 4.

102. * H. C. Frankenfield and A. J. Henry. St. Louis Tornado. Extract from Monthly Weather Review, 1896.

103. Monthly Weather Review for May, 1896. Vol. XXIV, No. 5.

104. Willis L. Moore. Responses to the programme of questions proposed for discussion at the International Meteorological Conference to be held in Paris, September, 1896.

105. Monthly Weather Review for June, 1896. Vol. XXIV, No. 6.

106. Monthly Weather Review for July, 1896. Vol. XXIV, No. 7.